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(54) Abstract Title
Pressure regulator for an inkjet printhead

(57) The printhead includes an ejector E (Fig.2) and an ink inflow pressure regulator R1 (Fig.2). The regulator is connected to an ink reservoir TR (Fig.2) by a hose ZS (Fig.2) and to the ejector by a hose AS (Fig.2) via fittings ZN (Fig.2) and AN (Fig.2) respectively. The regulator includes an inflow chamber ZK (Fig.1) at its top and an outflow chamber AK (Fig.1) at its bottom. Disposed between these chambers is a sealing plate valve DP (Fig.1) which is opened from below by a tappet ST (Fig.1). The tappet makes contact through a feeler T (Fig.1) with a diaphragm M (Fig.1) arranged on or towards the base of the outflow chamber. If a negative pressure occurs in the outflow chamber, the diaphragm bulges upwards to lift the feeler and valve which enables ink to flow from the inflow chamber through the open valve gap into the outflow chamber. The regulator maintains the supply pressure at the ejector at a virtually constant level, irrespective of the carriage accelerative forces and level of ink in the reservoir. For a multi-colour printer, several pressure regulators R1-R4 (Fig.2) can be arranged in alternating orientation in a casing block GK (Fig.2) mounted on the printhead by a flange F (Fig.2).

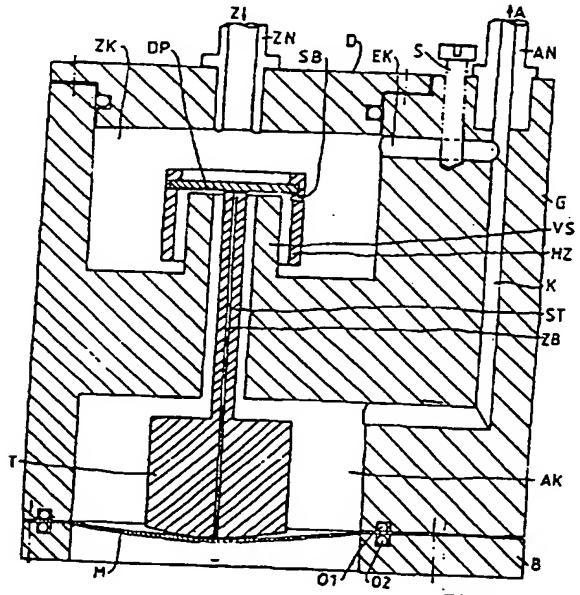

Fig. 1

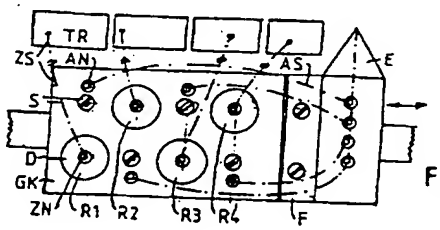

Fig. 2

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

This print takes account of replacement documents submitted after the date of filing to enable the application to comply with the formal requirements of the Patents Rules 1995

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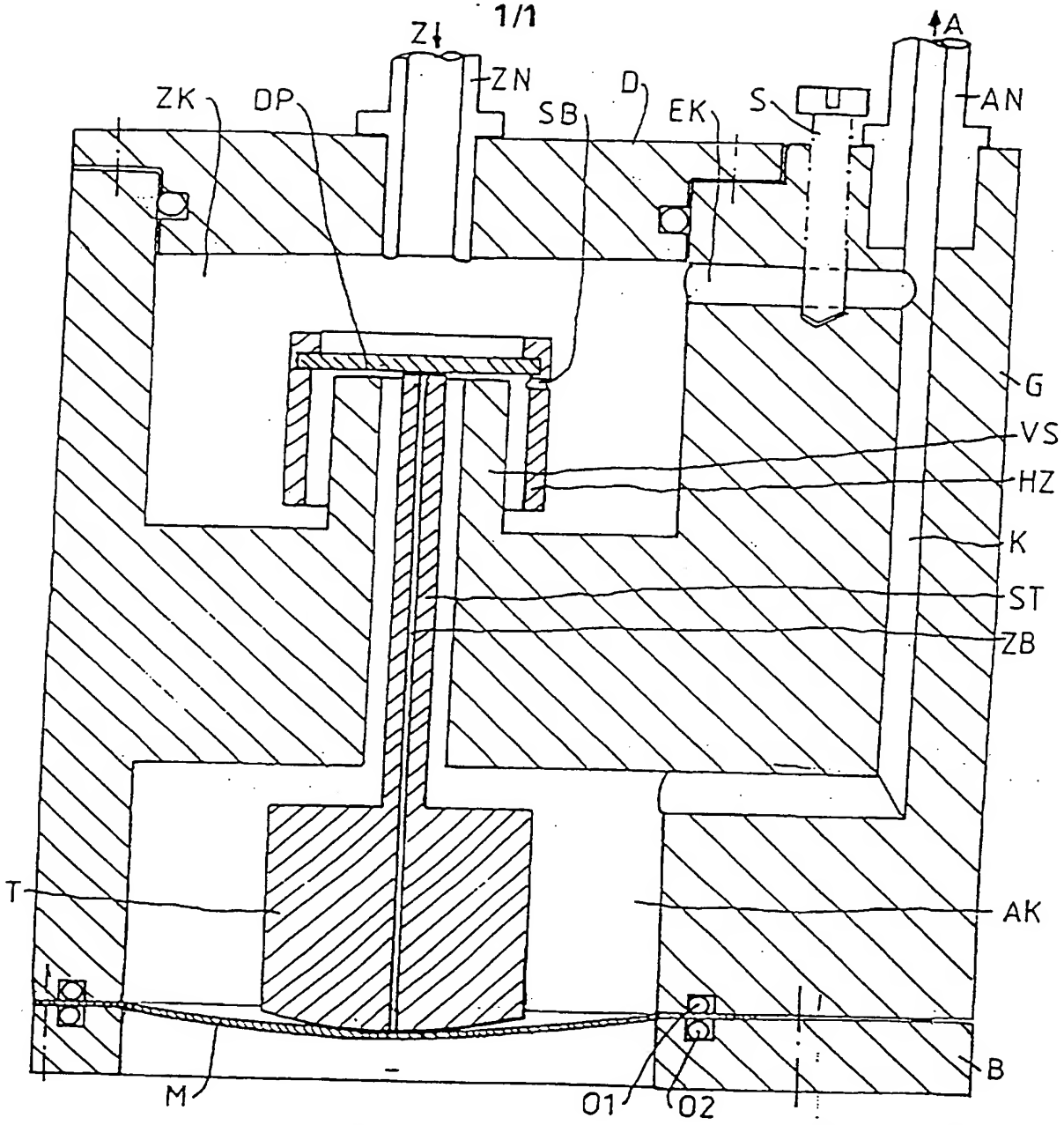

Fig. 1

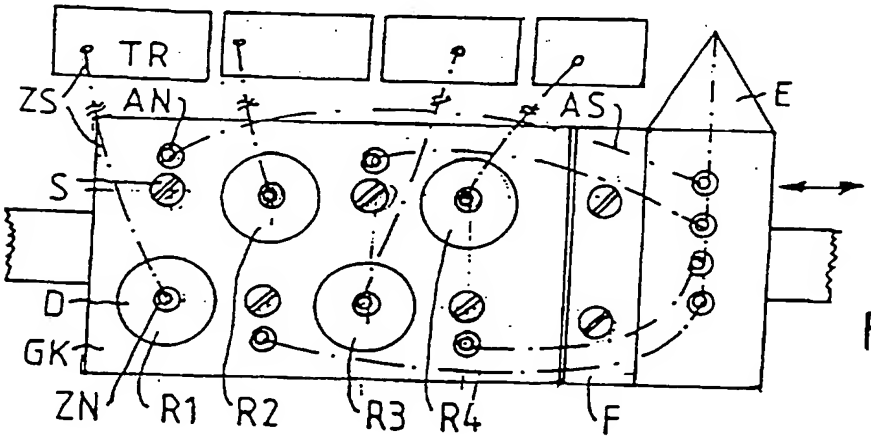

Fig. 2

PRESSURE REGULATOR FOR AN INK-JET PRINT HEAD

The invention relates to an ink-jet print head which includes an ejector connected via a hose to an ink reservoir.

Ink-jet print heads have a piezoelectrically controlled ejector duct which, on its inflow side, should be connected to an ink reservoir so that the capillary force in the inflow duct and the level of ink in the reservoir, as well as the subsequent flow of air to the reservoir, causes a narrowly restricted ink pressure range to be maintained in the ejector duct. This arrangement ensures that when the duct is excited it ejects droplets as uniformly as possible and the ink neither leaks out nor dries up when the printer is at rest. Since an ink-jet print head is moved so as to accelerate and decelerate it on a carriage over the printing area, acceleration forces give rise to fluctuations in the pressure of the ink. In order to counteract this, relatively small ink reservoirs were previously arranged directly on the movable head, but this means that the empty container needs to be replaced frequently. This is particularly troublesome when the print head is a multiple-colour print head, say for four colours, which run out at different points in time. If, on the other hand, larger reservoirs of ink are arranged in a fixed manner, the containers are then linked to the head by hoses in which the acceleration forces act and produce unwanted pressure fluctuations.

It is an object of the present invention to keep the supply pressure at the ejector duct virtually constant, irrespective of the accelerative forces and the level of ink in the reservoir.

This is achieved by arranging near the ejector an ink inflow pressure regulator, to which a hose runs from the ink reservoir.

According to the present invention, there is provided an ink-jet print head including an ejector which is connected via a hose to an ink reservoir and an ink inflow pressure regulator, the ejector also being connected to the ink inflow pressure regulator by a hose.

Practical refinements are indicated in the subsidiary claims.

Ink inflow regulators in accordance with the invention make it possible to provide a greater supply of ink at different levels even in the travelling reservoir; alternatively it allows a large reservoir to be arranged on the printer chassis. Pressure fluctuations in the hose are evened out by the regulator. A particular advantage is the fact that the regulator is relatively small in construction, with the result that in the case of a multiple-colour printer all the regulators can be constructed together in one travelling sub-assembly.

The regulator sub-assembly is assembled together from components that are relatively simple to manufacture. It can readily be opened for cleaning and inspection, and the replacement of components is a straightforward matter.

The fact that the regulator diaphragm has the ability to deflect creates a variable ink reservoir on the pressure-regulated side, from which ink may be drawn even if the inflow valve does not open for a time in the event of a high closure pressure being exerted on the valve element.

The sub-assembly can readily be fitted onto existing printers.

The invention will now be described by way of example only with reference to the accompanying diagrammatic drawings, in which:-

Figure 1 is a section to an enlarged scale taken through a regulator valve in accordance with the invention; and

Figure 2 is a plan view from above of a four-way sub-assembly in accordance with the invention.

The illustrated regulator valve is of coaxial construction and includes a lateral outflow A. Formed in the top of the valve casing G is an inflow chamber ZK and in the bottom an outflow chamber AK, between which chambers the valve element, a sealing plate DP, occludes a connection piece VS in a controlled manner.

The sealing plate DP is controlled via a tappet ST, which passes in a loose fit down the centre of the connection piece VS and makes contact through a barrel-faced feeler T with a diaphragm M which seals the outflow chamber AK towards the casing bottom.

The diaphragm M is cut in a circle from a thin foil of plastic, and is held sealed in the casing G between O-rings 01, 02. The feeler T and the tappet ST have a central bore ZB which facilitates aeration during the filling process.

The sealing plate DP is made of rubber and is held in a hollow cylinder HZ which extends in a loose fit over the connection piece VS and, as a freely suspended restoring weight, presses the valve plate DP into its closure position onto the rim of the connector and thus directly seals it. For the purpose of aeration the hollow cylinder HZ is provided with a lateral bore SB close to the sealing plate DP.

If a small, specified negative pressure occurs in the outflow chamber AK, the diaphragm M bulges upwards and begins to lift the feeler T along with the tappet ST, and hence the sealing plate DP with the hollow cylinder

HZ, thereby enabling a stream of ink to flow from the inlet chamber ZK, through the open valve gap and into the outflow chamber AK.

The outflow chamber AK is connected by an upwardly extending duct K to an outflow hose fitting AN, from which a short hose runs to the ejector.

The inflow chamber ZK is occluded by a lid D sealed by an O-ring. The lid D carries an inflow fitting ZN from which a hose leads to a fixed reservoir.

In the top of the inflow chamber ZK is a lateral aeration duct EK which leads to the duct K and is usually shut off by an adjustable venting screw S.

The lid D and a bottom locking plate B are screwed to the casing G and can readily be removed.

Figure 2 is a plan view from above of a four-colour regulator sub-assembly. The four regulators R1 - R4 are arranged in an integrated manner in a casing body GK with each positioned alongside the other in alternating orientation.

Of the individual regulators, the lid D can be seen in each case, along with the central inflow hose fitting ZN, the venting screw S and alongside it the outflow hose fitting AN. Constructed on the side of the casing body is a fixing flange F, by which it is mounted on the movable print head. The inlet hoses ZS lead to the ink reservoirs TR, and quite short hose connections AS lead to the head with the ejectors E.

CLAIMS

1. An ink-jet print head including an ejector which is connected via a hose to an ink reservoir and an ink inflow pressure regulator, the ejector also being connected to the ink inflow pressure regulator by a hose.

2. An ink-jet print head according to claim 1, in which a plurality of ink inflow pressure regulators are integrated in one casing body.

3. An ink-jet print head according to claim 1, wherein the ink inflow pressure regulator comprises an upper inflow chamber a lower outflow chamber connected through a valve which is actuated from below by a valve tappet so as to open it, and the tappet making contact in a force-transmitting manner with a diaphragm arranged on or towards the base of the outflow chamber.

4. An ink-jet print head according to claim 3, wherein the diaphragm is a circular foil which is held loosely tensioned in a sealing manner between sealing rings.

5. An ink-jet print head according to claim 4, wherein the valve tappet rests with a barrel-faced feeler against the diaphragm.

6. An ink-jet print head according to any of claims 3 to 5, wherein the valve tappet is guided vertically in a loose fit in a connection piece on which a sealing plate lies.

7. An ink-jet print head according to claim 6, wherein the sealing plate is circular and made of elastic material and is held by its rim in a hollow cylinder which loosely encloses the connection piece.

8. An ink-jet print head according to any of claims 3 to 7, wherein the inflow chamber is screwed shut by a sealed lid, and inserted into the lid is an inflow fitting onto which the inflow hose is pushed.

9. An ink-jet print head according to any of claims 3 to 8, wherein the outflow chamber is connected to a vertical outflow duct which terminates at the top in an outflow fitting from which an outflow hose leads to the ejector.

10. An ink-jet print head according to claim 9, wherein the inflow chamber is connected at the top via a lockable venting duct to the outflow duct.

11. An ink-jet print head according to claim 10, wherein the venting duct is lockable by a valve screw.

12. And ink-jet print head according to any of claims 3 to 11, wherein the valve, the inflow and outflow chambers and control elements of the valve are circular in construction and are arranged coaxially in a casing.

13. An ink-jet print head according to any of claims 3 to 12, wherein the valve tappet has an axial venting duct and the hollow cylinder has a lateral bore at its top for venting.

14. An ink-jet print head substantial as herein described and as described in accordance with the accompanying diagrammatic drawings.

The Patent Office

Application No:	GB 9825310.7	**Examiner:**	Gary Williams
Claims searched:	1-14	**Date of search:**	24 January 1999

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.Q): B6F: FLR

Int Cl (Ed.6): B41J: 2/175

Other: Online: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
X,P	EP 0838339 A2 (HEWLETT-PACKARD) See Fig.1, col.3 line 33 - col.4 line 6	1,2

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.